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SOME RESULTS OF ACTINOMETRIC MEASUREMENTS IN WATERS OF THE PACI--ETC(U)
FEB 77 V A RUTKOVSKAYA, B V KONOVALOV

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SOME RESULTS OF ACTINOMETRIC MEASUREMENTS IN WATERS OF THE PACIFIC OCEAN

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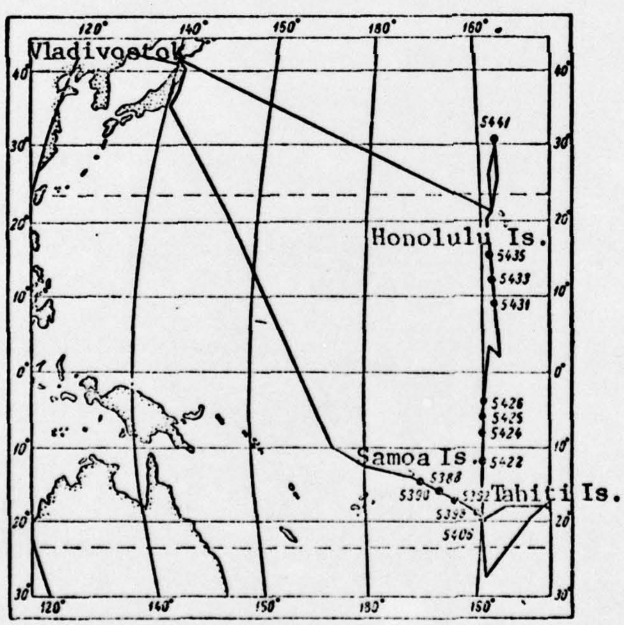
The investigation of the penetration of solar radiant energy into a water mass /193 is important in the study of the thermal regime and heat balance of bodies of water and of the photosynthesis processes occurring therein.

Underground irradiance data published thus far, obtained by means of an underwater pyranometer, characterize mainly bodies of fresh water.[1] Considerably fewer measurements have been performed in seas: in Kandalaksha Bay of the White Sea,[2] Pevek Bay in the East Siberian Sea,[3] in the Kara Sea,[4] and in the Black Sea, where the most detailed data were collected.[1,5-7]

In the Pacific Ocean (in its central part), irradiance determinations were made with an underwater pyranometer from May to July 1965 (37th cruise of the research ship VITYAZ'). The measurements were made at 13 stations (see figure). A total of 32 series of measurements were performed under different cloud cover conditions, heights of sun from 20 to 74°, sea states of 3-5 points, relative transparency of seawater (using a white disk) at 30-60 m and water color Nos. I and II on the standard scale. The thermal battery of the underwater pyranometer had a sensitivity of about 30 mW cm^{2} min/cal. The instrument was mounted on Cardan's suspension. The irradiance of the ocean surface was measured with a standard pyranometer.



Schematic map of stations (closed circles) with underwater actinometric measurements in the Pacific Ocean.
Arabic numerals near black circles indicate station numbers.

*Numbers in the right margin indicate pagination in the original text.

Table 1

$h_{\odot}$ (deg)	Height of sun $h_{\odot}$, deg				
	10–20	20–30	30–40	40–50	50–60
Depth z, m	Number of series				
	3	6	4	3	9
5	0.087	0.138	0.270	0.340	0.390
10	0.072	0.107	0.218	0.301	0.310
15	0.065	0.088	0.160	0.262	0.279
20	0.060	0.076	0.152	0.230	0.218
25	0.058	0.069	0.130	0.200	0.210
30	0.055	0.062	0.116	0.174	0.179
40	0.051	0.056	0.093	0.132	0.117
50	0.048	0.052	0.087	0.106	0.130
60	0.045	0.050	0.080	0.085	0.118
70	0.043	—	0.075	0.078	0.106

The recording instruments used were an EPP-09 strip chart recorder and an M-194 microammeter.

To characterize the highest absolute values of irradiance (cal/cm^2 min) at different depths, maximum values were selected at 10° height of sun intervals from observational results obtained under a cloudless or slightly cloudy sky (Table 1). /1

Comparison of these values with maximum irradiance values in the Black Sea[6] (relative water transparency >10 m) showed that at depths of 5, 10 and 15 m in the Pacific Ocean, the influx of solar energy is approximately 2 to 4 times greater than at the corresponding depths in the Black Sea. The values of these ratios increase with depth at all heights of sun (Table 2).

Table 2

Depth z, m	Height of sun $h_{\odot}$, deg		
	30–40	40–50	50–60
2	1.50	1.33	1.91
5	1.81	2.00	1.97
10	2.88	2.38	—
15	3.80	2.75	—

The maximum relative transparency for the Pacific Ocean was determined to be 60 m (close to the transparency of the Sargasso Sea and central Mediterranean) in the Samoa Islands - Kuka Islands section (st. 5392). The minimum measured transparency, 30 m, was observed in the Manuae Islands - Hawaiian Islands section (st. 5426). The penetration of solar energy into the water mass, expressed in percent of the energy incident on the surface (for the same height of the sun) at these two stations is given in Table 3. According to this table, the arrival of solar energy at a depth of 50 m in the transparent waters of station 5392 was 8.4%, and at station 5426, with less transparent waters, only 1.5%. /19

In measurements of irradiance in the surface water mass of other seas, a value of 6% was recorded in the East Siberian Sea (Pevek Bay) at a depth of 3-4 m,[3] in the White Sea (Pyr'ya Gulf) at 4 m,[2] in the Kara Sea at 25 m,[4] and off the Crimean and Caucasian shores of the Black Sea, at a depth of 15 m.[1,6]

Table 3

Depth z, m	Number of stations 5392	Number of stations 5426	Depth z, m	Number of stations 5392	Number of stations 5426
5	31	16	State of ⊙ disk	⊙²	⊙²
10	27	12	Cloud cover	5/5 Cu	3/3 Cu
15	22	8.2	$h_{\odot}$, deg	55°	55°
20	18	5.9	Relative transparency, m	60	30
30	13	3.8	No. of color on standard scale	1	11
40	9.7	2.4			
50	8.4	1.5			
60	7.4	—	Sea state, points	4	1
70	6.5	—			

Decimal indices of vertical attenuation α (Table 4) were calculated from a formula given in Ref. 8 on the basis of measurements in the Pacific Ocean. The minimum α values were 0.006-0.008 m^{-1}, and the maximum ones were 0.030 m^{-1}. /196

Mean values of this index for the water mass from 5 to 40-70 m are in the 0.011-0.23 m^{-1} range.

Table 4

Depth z, m	Number of stations, dates								
	5388 3.V	5390 4.V	5392 5.V	5398 7.V	5426 14.VI	5431 20.VI	5433 24.VI	5435 26.VI	5441 10.VII
5–10	0.014	0.014	0.012	0.020	0.030	0.016	0.018	0.018	0.016
10–15	0.018	0.021	0.019	0.024	0.030	0.020	0.019	0.014	0.010
15–20	0.012	0.008	0.016	0.012	0.030	0.008	0.016	0.010	0.008
20–25	0.016	0.020	0.014 (20–30)	0.028	0.020 (20–30)	0.018	0.013	0.012	0.010
25–30	0.020	0.012		0.026		0.016	0.008	0.016	0.008
30–40	0.014	0.013	0.011	0.019	0.020	0.015	0.010	0.013	0.013
40–50	0.011	0.014	0.011	0.018	0.020	0.012	0.011	0.010	—
50–60	0.010	0.010	0.006	0.012	—	0.008	0.010	0.010	—
60–70	—	—	0.006	0.010	—	0.010	—	—	—
Average for mass	0.014	0.014	0.011	0.017	0.023	0.013	0.013	0.012	0.014
$h_{\odot}$, deg	35	52	55	28	55	55	69	58	71
State of ⊙ disk	⊙²	⊙², ⊙	⊙²	⊙²	⊙²	⊙	⊙², ⊙	⊙²	⊙²
Cloud cover	4/4 Cu	3/3 Cu	5/5 Cu	—	3/3 Cu	10/5 Cu, Ci	3/2 Cu	3/3 Cu	2/2 Cu
Transparency, m	—	42	60	—	30	38	43	—	41

According to published data,[9] obtained by means of different types of submersible photoelectric underwater irradiance meters, the minimum α values for the most transparent ocean waters are 0.007-0.008 m^{-1}; on the average, for ocean waters 0.02-0.03 m^{-1}. Thus, values of the vertical attenuation index, measured by various detectors, are in sufficiently good agreement, this being natural, since the long-wavelength radiation to which a pyranometer is sensitive is absorbed by the upper layer of water.[10]

In studying both radiation and photosynthesis processes in the sea, of major importance is the determination of the diurnal sums of solar energy reaching a given depth. However, they are not easy to obtain, since measurements at different depths in the course of a day are difficult and require a long stay of the ship at the station.

Table 5

Depth, m	St. 5406				St. 5433				St. 5441			
	1	2	3	4	1	2	3	4	1	2	3	4
Air	306	0.81	100	100	550	1.34	100	100	705	1.2	100	100
5	74	0.19	24	23	149	0.37	27	28	123	0.20	17	17
10	60	0.16	20	20	118	0.31	21	23	117	0.19	16	16
15	56	0.15	18	18	108	0.26	20	19	109	0.18	15	15
25	48	0.13	16	16	80	0.21	14	16	91	0.14	13	12
35	43	0.11	14	14	60	0.17	11	13	77	0.12	11	10
50	40	0.10	13	12	47	0.14	8	10	59	0.09	8	8
75	38	0.09	12	11	36	0.10	6	7	51	0.07	7	6

Note. Columns 1-4 show: radiant energy per day (1), cal/cm^2; irradiance at midday (2), cal/cm^2 min; values of the ratio Q_z/Q_0 per day (3); Q_z/Q_0 at midday (4) in percent at different depths.

Table 5 gives the results of observations at stations 5406, 5433 and 5441, which showed that the ratios of solar energy that had penetrated to the same depth to the energy incident on the water surface according to observations during the day (Q_z/Q_0 day) and around noon (Q_z/Q_0 noon) were approximately the same.*

The identified correspondence is explained by the fact that the dependence of the coefficient Q_z/Q_0 on the height of the sun is appreciably manifested at small heights of the sun (when the influx of radiant energy amounts to an insignificant fraction of the total influx per day), and only in the upper levels. This dependence is already almost undetectable at 5 m in the Black Sea and 8 m in Lake Sevan,[11] and the value of the coefficient Q_z/Q_0 remains practically constant. /198

Therefore, with the hydrooptical properties of the water masses constant, the calculation of the solar energy penetrating to various ocean depths during one day may be performed approximately by using one series of measurements with an underwater pyranometer around noon and measurements of surface irradiance made with a surface pyranometer during one day.

REFERENCES

1. Rutkovskaya, V. A., Penetration of solar radiation into water reservoirs on dry land and in the sea. Trudy IOAN (Moscow), Vol. 78, 1966.

2. Kuz'min, P. P., Radiation reflected from the sea surface and absorbed by water layers of different depths. "Meteorologiya i gidrologiya," No. 7-8, 1939.

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*The differences apparent in the table between the quantities being compared are probably due to an inaccurate submersion of the instrument to a given depth in the presence of sizable waves.

3. Chernigovskiy, N. T., Actinometric observations on the steam ship REVOLYUTSIONER in 1940. Trudy Arkticheskogo nauch.-issled. in-ta (Leningrad), Vol. 62, 1954.

4. Andreyeva, N. N., The NMS-2 photopyranometer. Collected papers on meteorology. Trudy Arkticheskogo nauch.-issled. in-ta (Leningrad), Vol. 217, 1959.

5. Boguslavskiy, S. G., Absorption of solar radiation in the sea and its direct effect on the change in sea temperature. Trudy Morskogo gidrofizicheskogo in-ta AN SSSR (Moscow), Vol. 8, 1956.

6. Grishchenko, D. L., On solar radiant energy penetrating into the sea. Trudy Glavnoy geofizicheskoy observatorii (Leningrad), No. 68, 1957.

7. Pivovarov, A. A. and V. S. Lavorko, Vertical attenuation of solar radiation in the sea. Vestnik Mosk. Gos. Universiteta. Seriya III, Fizika, astronomiya, No. 6, 1960.

8. Kozlyaninov, M. V., Hydrooptical measurements in the sea. Trudy In-ta okeanologii (Moscow), Vol. 47, 1961.

9. Neuymin, G. G., N. A. Sorokina, A. N. Paramonov, and V. N. Proshin, Some results of optical studies in the north Atlantic Ocean. Trudy Morskogo gidrofizicheskogo in-ta (Kiev), Vol. 29, 1964.

10. Karabasheva, E. I., Yu. Ye. Ochakovskiy, and V. A. Rutkovskaya, Some results of comparison of various methods of measuring and calculating radiant energy in the sea. Okeanologiya (Moscow), Vol. 8, No. 2, 1968.

11. Kirillova, T. V., The Radiation Regime of Lakes and Storage Reservoirs (Radiatsionnyy rezhim ozer i vodokhranilishch), Leningrad, 1970.